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BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Application Number: 09/941,612
Filing Date: August 30, 2001
Appellant(s): AOYAGI ET AL.

Joe McKinney Muncy
For Appellant

SUPPLEMENTAL EXAMINER'S ANSWER

This is in response to the appeal brief filed 11/1/2004.

(1) Real Party in Interest

A statement identifying the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

A statement identifying the related appeals and interferences which will directly affect or be directly affected by or have a bearing on the decision in the pending appeal is contained in the brief.

(3) Status of Claims

The statement of the status of the claims contained in the brief is correct.

(4) Status of Amendments After Final

The appellant's statement of the status of amendments after final rejection contained in the brief is correct.

(5) Summary of Invention

The summary of invention contained in the brief is correct.

(6) Issues

The appellant's statement of the issues in the brief is correct.

(7) Grouping of Claims

The rejection of claims 4-21 and 26-36 stand or fall together because appellant's brief does not include a statement that this grouping of claims does not stand or fall together and reasons in support thereof. See 37 CFR 1.192(c)(7).

(8) Claims Appealed

The copy of the appealed claims contained in the Appendix to the brief is correct.

(9) Prior Art of Record

5,693,139	Nishizawa et al.	12-1997
5,739,554	Edmond et al.	4-1998
4,028,720	Pankove	6-1977
5,799,027	Anayama et al.	8-1998
6,472,690	Manabe	10-2002
5,231,298	Daly	7-1993

(10) Grounds of Rejection

1. Claims 4-21, 26-28 and 33-36 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nishizawa et al (US 5,693,139) in view of Edmond et al (US 5,739,554).

Nishizawa et al discloses a method of growing doped semiconductor monolayers, note entire reference, comprising raw material gases of Gallium (Ga) and Arsenic (As), where Ga is supplied for 0.5 to 10 seconds, the chamber is evacuated, this reads on applicant's purged for a predetermined time, and As is supplied for 2 to 200 seconds and the cycle is repeated (col 7, ln 1-67; col 8, ln 1-30 and Fig 7B and Fig 11). Nishizawa et al also discloses a p-type layer is formed by introducing an impurity gases and Ga simultaneously but alternately with an As source, where the impurity gas is an Mg, Zn or Cd containing gas or Silane. Nishizawa et al also discloses a n-type layer doped with Se or S and the impurity gas is introduced cyclically with the Ga gas and As gas or the impurity gas and Ga gas are introduced simultaneously but alternately with the As gas (col 8, ln 31-60). Nishizawa et al also discloses forming pnp bipolar transistors (col 8, ln 61-67). Nishizawa et al also discloses nozzles 44, 45 and 46 for introducing gaseous

compounds used for impurity doping for introducing group II, IV and VI gases (col 10, ln 50-67). Nishizawa et al also discloses different modes of doping, where the dopant is added at the exhaustion of an As gas, the introduction of a Ga gas, the exhaustion of a Ga gas or at the introduction of As gas (col 11-13 and Fig 11). Nishizawa et al also discloses other III-V semiconductors are applicable to the invention (col 14, ln 5-55). Nishizawa et al also discloses introduction of a Ga source gas and a group II dopant simultaneously to form a p-type layer (col 8, ln 30-45) and the introduction of a group IV dopant after the introduction of a Ga source gas (col 15, ln 5-50). Nishizawa et al also discloses selection of the timing of doping with respect of the source gas introduction is based on the desired dopant type for the monolayer being grown (col 15, ln 45-55).

Nishizawa et al does not disclose the given time for supplying each of the impurity raw materials are close to each other.

Edmond et al teaches a gallium nitride (GaN) layer co-doped with both a Group II acceptor and Group IV donor (col 4, ln 50-67), where the group II acceptors include Zn or Mg and the Group IV donors include Si or Ge (col 6, ln 20-50), this reads on applicant's the time for supplying each of the impurity raw materials are close to each other. Edmond et al also discloses the GaN layer is formed by CVD, where Trimethylgallium (TMG), ammonia, silane and biscyclopentadienyl magnesium, $(Cp)_2Mg$ are used as reactant gases (col 7, ln 45-67 and col 8, ln 1-50). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Nishizawa et al with Edmond et al to form a co-doped GaN layer useful as an active layer (Abstract).

The combination of Nishizawa et al and Edmond et al is silent to forming impurity pairs within at least one of the crystal raw materials. The combination of Nishizawa et al and Edmond et al teach supplying similar raw materials and impurities, as applicant. Also, the combination of Nishizawa et al and Edmond et al teach a similar method of supplying raw materials, purging and supplying impurities, as applicant. Therefore, the plural types of impurity raw forming impurity pairs within at least one of the crystal raw materials is inherent to the invention taught by the combination of Nishizawa et al and Edmond et al. The inherent forming of impurity pairs using co-deposition is evidenced by Pankove (US 4,028,720) and Anayama et al (US 5,799,027), below.

The combination of Nishizawa et al and Edmond et al is silent to causing a decrease in activation energy and an increase in carrier concentration. The combination of Nishizawa et al and Edmond et al inherently teach forming impurity pairs of similar raw materials and impurities, as applicant, therefore a decrease in activation energy and an increase in a carrier concentration is inherent because impurity pairs are formed. The formation of similar impurity pairs will be expected to have the same results of decreasing the activation energy and increasing carrier concentration. Furthermore, Applicant has admitted that the activation energy is decreased and the carrier concentration is increased as a result of forming impurities pair, note page 19, lines 11-17 of the reply filed on 8/25/2003, which provides evidence of the decrease in activation energy and increase in carrier concentration is inherent when impurity pairs are formed.

Referring to claim 4, the combination of Nishizawa et al and Edmond et al teaches forming a co-doped GaN layer using Mg and Si dopant, where the compound semiconductor

layer is grown in monolayer by alternate introduction of source gases and the chamber being evacuated continuously throughout the whole method ('139 col 3, ln 35-45) and the Si is introduced after the Ga source gas to act as a donor and a Ga source and a Mg dopant are introduced simultaneously but alternately with a As source.

Referring to claim 5, the combination of Nishizawa et al and Edmond et al teaches the introduction of a group IV dopant after the introduction of Ga and prior to the introduction of As and the introduction of group II dopant after the introduction of Ga and prior to the introduction of As (col 13, ln 10-35 and Fig 11).

Referring to claim 6-10, the combination of Nishizawa et al and Edmond et al teaches Ga as a first raw material gas and As or N as a second raw material gas.

Referring to claim 11-20, the combination of Nishizawa et al and Edmond et al teaches a co-doped layer with p-type and n-type impurities.

Referring to claim 21, the combination of Nishizawa et al and Edmond et al teaches using a silane dopant gas. The combination of Nishizawa et al and Edmond et al does not teach using a TESi dopant gas. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Nishizawa et al and Edmond et al by substituting TESi gas for silane because TESi is an equivalent Si source for doping and substituting equivalents for the same purpose is obvious (MPEP 2144.06).

Referring to claim 33-36, the combination of Nishizawa et al and Edmond et al teaches supplying reactants for a short period of time ('139 col 11, ln 50-60), this reads on applicants pulsed manner.

2. Claim 21 and 33-36 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nishizawa et al (US 5,693,139) in view of Edmond et al (US 5,739,554) as applied to claims 4-21 and 26-28 above, and further in view of Manabe et al (US 6,472,690).

The combination of Nishizawa et al and Edmond et al teaches all of the limitations of claim 21, as discussed previously, including using silane as a Si dopant. The combination of Nishizawa et al and Edmond et al does not teach supplying TESi

In a method of forming a gallium nitride compound semiconductor, note entire reference, Manabe et al teaches forming an n^+ type Gallium nitride layer, using silane or tetraethylsilane (TESi) (Example 4). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Nishizawa et al and Edmond et al with Manabe et al because substituting known equivalents for the same purpose is obvious (MPEP 2144.06).

Referring to claim 33-36, the combination of Nishizawa et al, Edmond et al and Manabe et al teaches supplying reactants for a short period of time ('139 col 11, ln 50-60), this reads on applicants pulsed manner.

3. Claims 29-32 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nishizawa et al (US 5,693,139) in view of Edmond et al (US 5,739,554) as applied to claims 4-21 and 26-28 above, and further in view of Daly (US 5,231,298).

The combination of Nishizawa et al and Edmond et al teaches all of the limitations of claim 29, as discussed previously, except the impurity raw materials are placed at a close

relationship with each other at a predetermined ratio without incorporating disorder into the crystal layer.

In a method of making a strain-free GaAs device, note entire reference, Daly teaches the epitaxial deposition of a strain-free, carbon doped p-type layer in a GaAs device to from the base layer thereof in a manner that includes the balancing of the strain of the crystal lattice structure caused by the carbon doping by co-doping the base layer with an isovalent and isoelectronic dopant, which also inhibits defect formation (Abstract), this reads on applicants without incorporating disorder into the crystal layer because strain from the impurity is balanced. Daly also teaches the amount of co-dopant required to counteract the carbon induced strain in the GaAs layer is proportional to the amount of carbon employed for p-doping (col 2, ln 50 to col 3, ln 20), this reads on applicants predetermined ratio. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Nishizawa et al and Edmond et al by controlling the co-dopant to prevent strain as taught by Daly to form a strain free layer.

4. Claims 32 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nishizawa et al (US 5,693,139) in view of Edmond et al (US 5,739,554) and Manabe et al (US 6,472,690), as applied to claim 21 above, and further in view of Daly (US 5,231,298).

The combination of Nishizawa et al, Edmond et al and Daly teaches all of the limitations of claim 32, as discussed previously, except the Mg and Si are placed at a close relationship with each other at a predetermined ratio without incorporating disorder in a layer of Ga.

In a method of making a strain-free GaAs device, note entire reference, Daly teaches the epitaxial deposition of a strain-free, carbon doped p-type layer in a GaAs device to from the base layer thereof in a manner that includes the balancing of the strain of the crystal lattice structure caused by the carbon doping by co-doping the base layer with an isovalent and isoelectronic dopant, which also inhibits defect formation (Abstract), this reads on applicants without incorporating disorder into the crystal layer because strain from the impurity is balanced. Daly also teaches the amount of co-dopant required to counteract the carbon induced strain in the GaAs layer is proportional to the amount of carbon employed for p-doping (col 2, ln 50 to col 3, ln 20), this reads on applicants predetermined ratio. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Nishizawa et al and Edmond et al by controlling the co-dopant to prevent strain as taught by Daly to form a strain free layer.

(11) Response to Argument

Applicant's arguments filed 11/1/2004 have been fully considered but they are not persuasive.

The primary issues regarding the rejection of the pending claims in view of the prior art of record are whether the prior teaches all of the limitations and whether the effects of the claimed invention would inherently occur. Appellants' invention is the supply of crystal raw materials and n-type and p-type impurity gases by cycling raw material and impurity raw material separated by a purge gas, which is taught by Nishizawa et al, note Figure 11 and Claims 16 and 19. Edmond et al teaches the use of a plurality of impurity gases in a co-doping process,

which the Examiner maintains reads on Appellants' supplying each of the impurity gases for a given time, where the timing are close to each other, because co-doping by definition means the two dopants are supplied to a single layer. Regarding the inherency argument, the Examiner has provided secondary references supporting the Examiner's position that the effects of the claimed invention, forming impurity pairs, would occur from co-doping, which Appellants have chosen to ignore because the references were not included in the heading of the rejection and only provided in the body of rejection along with column and line location of information citing the portions used by the Examiner.

Appellants' argument that the Examiner is incorrect for relying on Pankove (US 4,028,720) and Anayama et al (US 5,799,027) as evidence of inherency (pg 9) is noted but is not persuasive. Appellants allege that because the Examiner did not apply the references as part of the rejection, relying on these references as evidence of inherency is incorrect. The Examiner clearly stated in the body of the rejection, page 4 of the final rejection, that Pankove and Anayama et al were relied upon as evidence of inherency and also clearly stated on page 11 of the final rejection the exact column and line cites of Pankove and Anayama used by the Examiner. Appellants' arguments are based only on semantics because the references were not included in the heading of the rejection. Clearly, the Examiner has included the references in the rejection by stating that Anayama and Pankove were relied upon as a teaching of inherency and Appellants have had the opportunity to contest the teachings of Anayama and Pankove, but Appellants have chosen to ignore their teachings because the references were not included in the heading of the rejection. Furthermore, MPEP 2112 states once the Examiner present evidence or reasoning tending to show inherency, the burden shifts to the applicant to show an unobvious

difference. MPEP 2112 does not require the evidence tending to show inherency to be incorporated in the heading of the rejection and Appellants' have not met their burden showing an unobvious difference to properly rebut the inherency position taken by the Examiner.

Appellants' argument that co-doping does not indicate that the time for supplying the impurity materials are close to each other is noted but is not persuasive. Appellants allege that co-doping in general does not teach supplying each of the plural types of impurity raw materials, where the given time for supplying each of the impurity raw materials are close to each other. Firstly, Appellants require that the given time for supplying each of impurity raw material are ***close*** to each other. The term "close" is extremely broad and is open to many different interpretations. Appellants teach "close" timing means that the impurity is supplied at the same time, after or before the supplying of raw materials (page 3, line 22 to page 4, line 5); therefore many different interpretations of "close" reads on Appellants' "close timing". Secondly, co-doping a single layer with n-type and p-type dopants requires the dopants to be in "close timing" together because if the dopants are not in close timing then the layer would not be co-doped but rather two different layers with a single type dopant. Thirdly, co-doping by definition meets the required limitation. Merriam-Webster defines "co-" to mean with, together; therefore the n-type and p-type dopants are by definition supplied together, which reads on Appellants' "close timing" because Appellants teach that "close timing" encompasses supplying the impurities at the same time. Finally, Nishizawa et al teaches supplying first and second dopant gases with a first or second compound gas and cyclically repeating introduction and exhaustion of gases (claim 16 and claim 19). The dopants are supplied at least within one cycle of the two deposition gases, which reads on applicants' "close" timing. Nishizawa et al requires pulsing of reactants

and dopants in a cyclical manner; therefore to co-dope, as taught by Edmond et al, requires both dopants within at least one cycle.

Appellants' argument that Edmond et al teaches continuous supply is noted but is not persuasive. Appellants' allege that Edmond et al teaches forming a layer with a net conductivity, which teaches away from impurity materials being close to each other (page 10, line 20 to page 11, line 5). Appellants argument only strengthens the Examiners position that co-doping requires the supply of both types of impurities at the same time, which reads on Appellants supply of impurities in close timing, because Appellants argue the teachings of Edmond requires continuous supply of impurity materials. The continuous supply of impurities suggests that the impurities are supplied together with the raw materials. Nishizawa et al is relied upon as a teaching of separate raw material and impurity gas pulsed. Edmond is relied solely upon as a teaching of supplying a plurality of impurity gases at the same time, which reads on Appellants' "close timing".

In response to applicant's arguments against the references individually, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986). Edmond et al is allowed to teach the conventional process of continuous supply of raw material and impurity raw materials without purging because this feature is taught by Nishizawa et al. Nishizawa et al teaches the alternate introduction of raw materials and impurities gases separated by a purge. Edmond et al is relied upon solely as teaching that supplying two different types of impurities at the same time to form a co-doped semiconductor is known.

Appellants' argument against the inherency position taken by the Examiner regarding the features in the final paragraph of claim 26 is noted but is not persuasive. Appellants' allege that since conventional types of co-doping taught on page 2 of the specification have used co-doping without producing the claimed features; therefore the claimed features would not be inherent in view of Nishizawa and Edmond's teachings. However, this argument ignores the teachings of Nishizawa. Nishizawa teaches the pulsing a raw material AsH_3, an impurity gas A, B, C, or D and a raw material TEG (Fig 11), as Appellant (page 11, lines 20 to page 12, line 19 of the specification). Appellant teaches the advantage of the instant invention is the pulsing of raw materials and impurity gas instead of a continuous supply method (page 11, lines 13-24 of the specification). Continuous supply co-doping differs from the Examiners position of inherency in view of the combined teachings of Nishizawa and Edmond. The Examiner maintains that pulsing raw material and impurity gases with co-doping inherently forms impurity pairs because co-doping forms impurity pairs, as evidenced by Pankove (US 4,028,720) and Anayama et al (US 5,799,027), and Appellants attribute the decrease in activation energy and increase carrier concentration from the formation of impurity pairs using co-doping. The combination of pulsed deposition with co-doping is the method used by Appellants to obtain the claimed effects and the method used by Appellants is obvious in view the combined teachings of Nishizawa and Edmond. Furthermore, Appellants teach on page 21, lines 9-14 of the specification that a Mg-Si impurity pair is formed by supplying a p-type and n-type impurity raw material, which supports the Examiner's position that the presence of p-type and n-type dopant will inherently form an impurity pair.

Appellants' arguments regarding claims 27 and 28 are noted but are not found persuasive. Appellants allege that Edmond et al does not teach supplying impurity materials either at the same time or after the start of the supply of crystal materials. Nishizawa et al teaches n-type or p-type dopants are introduced simultaneously with at least one of the crystal materials (claims 16 and 19).

Appellants' argument that the second step of supplying TESi is not obvious over the combination of Nishizawa et al and Edmond et al or the combination of Nishizawa et al, Edmond et al and Manabe et al is noted (pgs 13-15) but not persuasive. The Examiner admits that the combination of Nishizawa et al and Edmond et al does not teach using TESi, which is a well-known dopant for III-V semiconductors; therefore would have been obvious to a person of ordinary skill in the art at the time of the invention. Manabe et al is also provided to show TESi as a dopant for III-V semiconductors. The Appellants allege that the prior art does not teach supplying TESi after TMGa and $(Cp)_2Mg$. Nishizawa et al teaches pulsing reactant gases and impurity gases and supplying n-type and p-type dopants (claims 16 and 19), a deposition order of III-IV-V and the determination of the sequence of source gases and impurity gas introduction is based on the impurity being doped (col 15, ln 30-50). Nishizawa et al specifically teaches an order of III-IV-V reactants and as claimed TMGa, a group III reactant, is supplied and then TESi is supplied, a group IV reactant. Nishizawa teaches the sequence of supplying a group III reactant followed by a group IV impurity. The order of the supplying reactants and impurities is not novel because the prior art teaches the order is determined from the impurity being doped.

Appellants' arguments regarding claims 33-36 are noted but are not found persuasive (pg 15). Appellants allege that Manabe et al does not teach pulsing reactants. The Examiner has not

relied upon Manabe et al to teach pulsing reactants or dopant gases. Manabe et al is provided solely to teach the obviousness of using TESi instead of silane as a dopant gas for a III-V compound semiconductor. Nishizawa et al is relied upon to teach the pulsing of reactant and impurity gases, as discussed previously.

Appellants' arguments regarding claims 29-32 are noted but are not found persuasive (pg 16). Appellants allege that Daly et al teaches the deposition of a strain-free epitaxial layer, which is not equivalent to a layer without disorder. Daly et al teaches a method of forming a strain-free epitaxial layer by doping with an amount of a co-dopant to counteract the induced strain caused by p-doping (col 2, ln 50 to col 3, ln 20). With regard to crystalline structures, it is well known in the art that strain and disorder is directly proportional. The more disorder in a crystalline lattice resulting from elements residing at crystalline positions, which are unnatural, will cause strain. Therefore, producing a strain-free layer requires depositing the elements of that layer at highly ordered positions or in other words without incorporating disorder.

In response to appellant's argument that there is no suggestion to combine the references, the examiner recognizes that obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found either in the references themselves or in the knowledge generally available to one of ordinary skill in the art. See *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988)and *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992). In this case, Daly et al teaches a method of forming a strain free layer by controlling the amount of a co-dopant and strain free layers are desirable, as taught by Daly; therefore there is proper motivation to modify Nishizawa et al, Edmond et al and Manabe et al with Daly.

In conclusion, Edmond's co-doping is relied upon by the Examiner as a teaching of supplying impurity raw because co-doping, by definition, requires the supply of a plurality of dopants to the same layer in a "close timing" to form a co-doped layer, which Appellants disagree because Edmond does not explicitly teach when the raw materials are supplied. Also, the Examiner maintains that the Appellants have not properly rebutted the inherency position taken by the Examiner because the Appellants have not addressed the teachings supporting the Examiner's position of inherency and Appellants have not shown an unobvious difference. Nishizawa et al teaches pulsing dopants and reactants in a cyclic fashion; therefore since both dopants are within the same cycle, the dopants are in "close" timing to each other.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

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February 18, 2006

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